

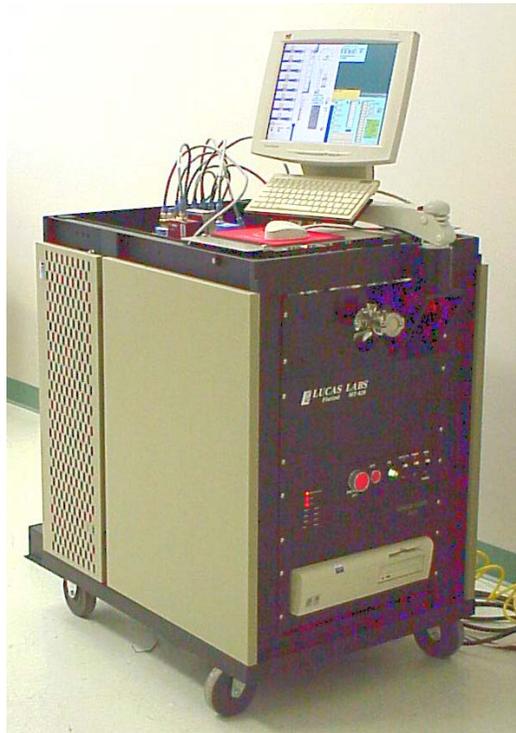
## *Florizel 2003*

### For Study and Testing of Mass Flow Controllers

Florizel is a NIST traceable measurement tool for evaluation of Mass Flow Controllers (MFCs) performance when flowing into a vacuum. The new digital MFCs allow users to set-up a generic MFC to have a specific gas and range. Florizel is a valuable platform for setting up the digital MFCs then verifying they are performing within specification. In fact, several of the major MFC manufacturers use Florizel for testing and developing their calibration curves. Also, Applied Materials has developed strict acceptance standards for the transient characteristics of MFCs based on the parameters measured by Florizel. Florizel may be set up to run with analog, digital or DeviceNet MFCs.

Florizel was originally conceived to study performance of Mass Flow Controllers when attached to vacuum based process tools. Florizel employs the *rate of rise* method of measurement for analysis. It features a 25 liter tank with a vacuum system capable of pumping to  $10^{-6}$  Torr. Tests are started at about 50mT and the pressure is monitored.

Comparison is made of the reported flow from the MFC and the *Rate of Rise* calculated flow.



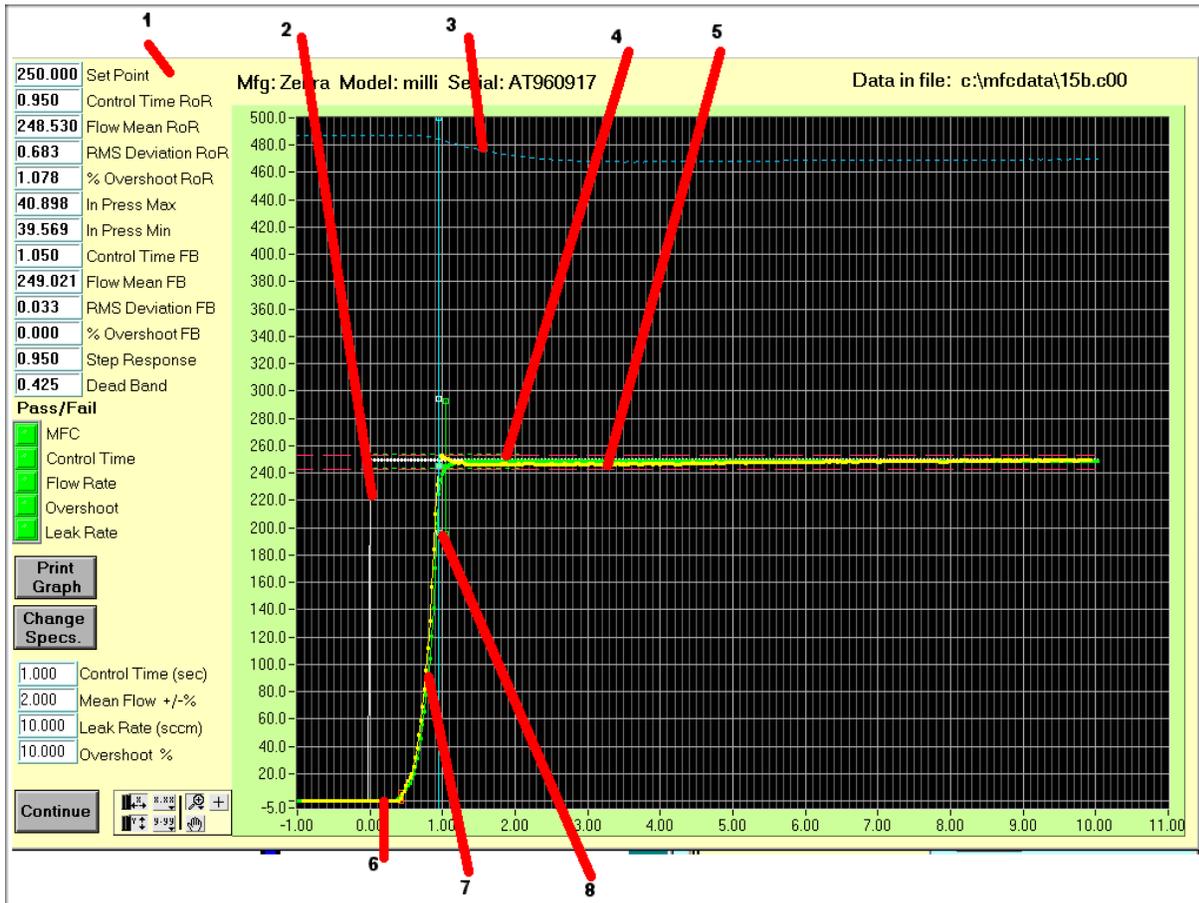
These key parameters are reported for each flow rate-

- Dead time – *time from command to start until flow is actually detected, rate of rise*
- Step response – *time from command to start until reaching the control band, rate of rise*
- Overshoot ROR – *flow beyond the set point as a percent of flow, set point or full scale, rate of rise*
- Overshoot FB - *flow beyond the set point as a percent of flow, set point or full scale, MFC reporting*
- Control time ROR – *time from command to start until flow stays within the control band, rate of rise*
- Control time FB – *time from command to start until flow stays within the control band, MFC reporting*
- Mean Flow ROR- *average flow rate after reaching control, rate of rise*
- Mean Flow FB- *average flow rate after reaching control, MFC reporting*
- RMS Deviation at Flow ROR- *variance of flow after reaching control, rate of rise*
- RMS Deviation at Flow FB- *variance of flow after reaching control, MFC reporting*
- Input Pressure- *the measured maximum and minimum pressure supplied to the MFC*

After running several flow rates and repetitions of each flow rate, the following parameters are reported-

- Average gain – *the average slope of flow rates based on the mean flow, rate of rise data*
- Offset – *the average offset reported in SCCM based on the mean flow, rate of rise data*
- Linearity – *the average variance from the gain measured in SCCM based on the mean flow, ROR*
- Maximum RMS/Flow – *the maximum RMS Deviation measured in any mean flow ROR measurement*
- Repeatability – *Average percent of repeatability for all flow rates, based on mean flow, ROR*
- Sensor 0 Offset – *MFC reporting when there is no flow, but commanded to flow.*

*Florizel's* screen graph provides excellent information for analysis. The graph may be zoomed, printed or exported for further analysis. The graphic data is found to be most useful in comparing the *rate of rise* data to the MFC reported data.



- 1- Measured parameters used in the summary report.
- 2- White line indicates the electronic signal sent to the MFC.
- 3- Dashed blue line indicates the input pressure to the MFC.
- 4- Green line indicates the flow as reported by the MFC.
- 5- Yellow line indicates the flow as indicated by the pressure sensors using *rate of rise*.
- 6- Dead time- from 0 time until flow begins
- 7- Step response- from 0 time until flow crosses the flow control parameter the 1<sup>st</sup> time.
- 8- Control time- from 0 time until flow crosses the flow parameter for the last time.

At the end of the run, a summary graph is also displayed. The summary report is created and placed into a text file. The file may be printed, exported or e-mailed for further analysis.

